AIR QUALITY THUNDER BAY

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AIR QUALITY
THUNDER BAY

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SUMMARY

The 1975 air quality survey in Thunder Bay monitored levels of dustfall, suspended particulate, sulphur dioxide, carbon monoxide, mercury and hydrogen sulphide.

Dustfall and suspended particulate levels, at 14 and 7 sites respectively, both frequently exceeded Ontario air quality criteria. Highest values were associated with spring months (April-June) and easterly winds. Annual averages, since 1970, have provided little evidence of significant improvement. Although grain elevators are considered the principal local industrial source of dust emissions, it is recognized that part of total dustfall measured originates from re-entrainment of ground-level dust. Concentrations of cadmium, copper, lead, manganese, nickel and vanadium were low.

Sulphation rates at 10 sites were generally low from 1970 to 1975, and provincial criteria were rarely exceeded. Highest values usually occurred in winter, when higher sulphur fuels were consumed.

Sulphur dioxide (SO_2) levels, monitored with continuous analyzers, were very low in 1975, but most local industrial sources of SO_2 were non-operational during the latter part of the year. The one-hour criterion for SO_2 has been exceeded only four times in five years in Thunder Bay. Special surveys with a mobile van showed that, with one exception, SO_2 levels were within Ontario standards downwind of four sulphite pulp mills.

The mobile monitoring unit detected elevated carbon monoxide concentrations near certain roadside locations where vehicular traffic was substantial.

Mercury concentrations at a waste disposal site near a former chemical plant were well below the Ontario standard.

Hydrogen sulphide levels, continuously monitored at one location for the second half of the year, were very low at all times.

INTRODUCTION

Atmospheric contaminants have been monitored in the city of Thunder Bay since 1963, when a high volume sampler was installed at 14 Algoma Street, Port Arthur, to measure suspended particulate. In 1970, instrumentation was expanded to include devices for recording dustfall, suspended particulate and sulphation rate. Several revisions were made after 1970, depending on site suitability and availability of manpower to operate the network. In 1975 there were 14 stations for dustfall measurement, 7 for suspended particulate and 10 for sulphation.

Instruments for the continuous monitoring of air pollutants were first used in Thunder Bay in October, 1971 when Ontario Hydro installed a sulphur dioxide analyzer at their Walsh Street sub-station. Four other sulphur dioxide units were added by Ontario Hydro in 1975 and, in the same year, Ministry of the Environment established two sulphur dioxide monitoring stations in the city, one at Dawson Court, Algoma Street North, and one at the Ontario Government Building, James Street South. The latter site also included an instrument to record concentrations of hydrogen sulphide.

In June, 1975, special air quality surveys were carried out by the Ministry's mobile van in the vicinity of sulphite pulp mills in Thunder Bay.

DUSTFALL

Dustfall and suspended particulate are the most visible of all classes of air pollutants. Dustfall comprises the larger particles which settle out from the atmosphere under the influence of gravity. It is measured by exposing open top vessels of specified dimensions for periods of 30 days. Total dustfall collected is weighed and results are expressed in tons per square mile per month.

Dustfall jars were exposed at 14 locations in Thunder Bay in 1975 (Figure 1), and results are summarized in Table 1 and Figure 2. Historical comparisons are given in Table 2 and plotted graphically in Figure 3.

The data were also summarized for all stations and years into categories for winter (January-March), spring (April-June), summer (July-September) and autumn (October-December). Dustfall averages were 9 tons in winter, 19 in spring, 16 in summer and 11 in autumn. The trend of high values in spring and summer and low levels in autumn and winter was noted for all locations and years.

The relationship between dustfall and wind direction was also investigated. For all stations and years, the average dustfall was 13 tons with monthly prevailing wind from the west and 17 tons with easterly wind. Five of the 24 locations did not agree with this trend and had higher dustfall levels with westerly winds.

Dustfall in 1975 and earlier years has frequently exceeded Ontario monthly and annual criteria at many locations in Thunder Bay. Highest values were usually found near grain elevators, the principal contributor of dustfall from industrial sources. There has been no obvious trend toward decreasing dustfall levels in recent years (Figure 3), but evidence of this should become more apparent in the next two years as major improvements in grain elevator dust control systems become effective.

The occurrence of highest dustfall levels in spring and summer coincides with maximum activity in grain handling and shipping. It is believed, however, that part of the high springtime levels may be ascribed to re-entrainment of dust blown up from ground level. This situation would have maximum impact in the period between snow melt and the development of summer vegetation, and minimum effect when dirt roadways and carparks were frozen and snow covered.

The association of higher dustfall levels with easterly wind supports other evidence that emissions from grain elevators contribute significantly to city dustfall. Most monitoring stations would be downwind of grain elevators with easterly wind. One notable exception is the dustfall jar on Mission Island (station 63021) which receives particulate loading from operations at Valley Camp Ltd.

SUSPENDED PARTICULATE

Suspended particulate constitutes particulate matter of small size (0.1 to 100μ) which remains in the atmosphere for extended periods of time. Concentrations of this material are determined with high volume samplers operated continuously for 24 hours every sixth day, yielding four or five samples per month. About 1.5 cubic metre of air per minute is drawn through a pre-weighed glass fibre filter which is removed at the end of the sampling period and weighed to determine the quantity of suspended particulate matter deposited. Units are expressed in micrograms per cubic metre of air ($\mu g/m^3$). Filters are sometimes also analyzed to determine the concentration of lead or other heavy metals.

Data were collected from seven locations in 1975 (Figure 4) and results are presented in Table 3 and Figure 5. Values for earlier years are summarized in Table 4 and plotted in Figure 6. Concentrations of lead and other heavy metals at station 63022 (14 Algoma Street) are given in Table 5.

Results were grouped into the same four seasonal categories used for dustfall. For the 1970 to 1975 period, average concentrations were $45\mu g/m^3$ in winter, 116 in spring, 81 in summer and 50 in autumn. This general trend applied to all stations and years.

In analyzing the relationship between suspended particulate levels and wind direction, only those values were included which applied to sampling periods during which wind direction was easterly or westerly for the entire 24-hour sampling period. For 367 values for west winds and 167 for easterly winds, the average particulate loading was 52 and 100 $\mu g/m^3$ respectively.

As noted for dustfall, suspended particulate levels have frequently exceeded daily and annual criteria established by provincial regulation. Highest concentrations were recorded at station 63017 (Inter-City area) and the lowest at station 63018 (St. Ignatius School) and the Ontario Government Building (James Street South). Station 63017 is close to a major concentration of grain elevators and the other two sites are remote from industrial sources

of particulate. There has been a trend toward a slight decrease in particulate levels in recent years (Figure 6) and further improvement is expected in the near future.

Analysis of exposed filters for heavy metal content has shown that levels of six elements were very low. No values exceeded Ontario criteria.

Highest levels of both dustfall and suspended particulate were associated with spring months and easterly winds. The months of April, May and June coincide with prevailing easterly winds, a high level of activity in the grain elevator industry and maximum exposure of dirt-covered areas in the city.

SULPHATION

Sulphation rate is measured by exposing lead dioxide candles or plates of known surface area to the air for 30 days. The lead dioxide reacts with sulphur compounds in the atmosphere to form lead sulphate. Results are expressed in milligrams of sulphur trioxide per hundred square centimetres per day (mg SO_3/100 cm^2/day). These monitoring devices are normally used to detect whether significant sulphur dioxide contamination is present in an area. However, because of its oxidizing power, lead dioxide converts other reactive sulphur compounds such as hydrogen sulphide and mercaptans into sulphate. As a rough guide, sulphation rate is multiplied by 0.03 to obtain an estimate of average sulphur dioxide concentrations in parts per million (ppm).

Sulphation rates for 10 monitoring stations (Figure 7) for 1975 are shown in Table 6. Table 7 summarizes data for the period 1970-75. In relation to prevailing wind, the average sulphation rate was 0.10 mg for westerly winds and 0.11 mg for easterly winds. Seasonal values were 0.14 in winter, 0.11 in spring, 0.07 in summer and 0.09 in autumn. At only one site (station 63019--Main Street Sewage Plant) was the sulphation rate higher in summer than winter.

The data show that levels of reactive sulphur-containing gases were generally low from 1970 to 1975. Only seven values out

of 738 exceeded the pre-1975 criterion of 0.40 mg, and none were greater than the current criterion of 0.70. Highest rates were recorded at station 63004 (24 Mountain Road) and at station 63019 (Main Street Sewage Treatment Plant). Levels at Mountain Road presumably reflect proximity to Abitibi's Mission Mill. At the Sewage Treatment Plant, highest rates usually occurred in summer and probably resulted from emissions of gaseous sulphur compounds from the plant itself.

As expected, there was no apparent association between prevailing wind and observed sulphation rates. The occurrence of highest seasonal values in winter was attributed partly to emissions from residential heating sources but principally to the use by local industry of a greater proportion of higher sulphur fuels (coal and oil) during winter months.

SULPHUR DIOXIDE

Sulphur dioxide is a colourless gaseous pollutant, major sources of which are combustion of sulphur-containing fuels or processes involving the heating of sulphur-containing mineral ores. No major sulphur dioxide sources occur in Thunder Bay, but some sulphur dioxide is emitted by four sulphite mills, by Ontario Hydro's generating station on Mission Island and by combustion of fuels by local industry. Adverse effects of sulphur dioxide include irritation of respiratory systems in humans and animals, injury to vegetation, reduced visibility and corrosion of building materials.

(a) Continuous Monitoring

Continuous sulphur dioxide (SO_2) analyzers used in Thunder Bay have been of two types. One utilizes the principle of electrical conductivity, in which sample gas is dissolved in deionized water, forming sulphuric acid. The resulting increase in conductivity is measured electrically and is proportional to the SO_2 concentration in the sample. This detection principle is simpler than others in current use, but suffers the disadvantage of interference by many other

contaminants affecting the conductivity of the absorbing solution. A second type of SO_2 analyzer in Thunder Bay uses the principle of continuous coulometric titration. An air sample is drawn through a detection cell containing an anode, a cathode and a reference electrode immersed in a buffered solution of potassium bromide. Sample gas reacts with bromine in the electrolyte to cause an electro-chemical imbalance in the cell which is measured by the reference electrode and is proportional to the SO_2 concentration in the sample. This principle applies equally to SO_2 or hydrogen sulphide (H_2S) detection. For SO_2, a selectivity filter permits only SO_2 to enter the instrument and for H_2S measurement, a filter removes all gaseous pollutants except H_2S and mercaptans.

Figure 8 illustrates the locations of SO_2 monitoring stations in Thunder Bay. Five are operated by Ontario Hydro and two by Ministry of the Environment. From October, 1971 to November, 1974 the only instrument in use was located on Walsh Street (station 63023). During this period, the provincial hourly criterion of 0.25 ppm was exceeded on only three occasions, twice in July, 1973 and once in August, 1974. The maximum hourly value recorded was 0.40 ppm (August 20, 1974). The Ontario daily or annual criteria (0.10 and 0.02 ppm respectively) were not exceeded at any time.

In 1975, the Ontario Hydro network was expanded to five stations. During the year, the hourly criterion was exceeded only once and the value on that occasion was 0.33 ppm on January 28 at the station on top of Mt. McKay. All daily averages were within Ontario regulations, the maximum being 0.08 ppm reached during April. Sulphur dioxide levels were very low during the second half of the year.

The two Ministry of the Environment monitors were in operation from June to December. All sulphur dioxide levels were well within Ontario criteria for 1-hour and 24-hour periods. The maximum 1-hour value was 0.10 ppm at Dawson Court and 0.03 ppm at 435 James Street.

Sulphur dioxide concentrations were low at all monitoring stations in 1975 and extremely low levels were recorded from July to

December. Emissions from the main local sources were also unusually low in 1975, especially in the second half of the year. Ontario Hydro's plant on Mission Island generated power for only 32 days, all during the first six months of the year. Because of labour disputes, three sulphite mills ceased operations on July 11 and the fourth closed in early September.

(b) Special Surveys

In June, 1975, a Ministry of the Environment mobile monitoring unit carried out air quality surveys in the vicinity of sulphite pulp mills in Thunder Bay. Although the van was equipped to monitor several pollutants, attention was directed mainly to sulphur dioxide measurements. Depending on accessibility and wind direction, attempts were made to position the van downwind of the source under investigation and to monitor ambient air for periods of at least 30 minutes. Where possible, monitoring coincided with scheduled digester blow-down operations at the pulp mills. Blow-down periods occurred about every 4-6 hours and lasted 10-30 minutes each.

Downwind of the Great Lakes Paper sulphite mill, the Ontario standard of 0.30 ppm (30 minute average) was not exceeded at the times and locations specified (Table 8). The peak concentration of 2.01 ppm was recorded on July 23 at the trailer park southeast of the mill (Figure 9). Lowest sulphur dioxide levels were found in the vicinity of Abitibi's Thunder Bay mill. At the Abitibi Provincial mill, a mean value of 0.41 ppm was measured on June 25, but the standard was not violated since the monitoring period was less than 30 minutes. Highest SO_2 concentrations were found on June 25 west of Abitibi's Mission Mill. Here, a mean of 0.81 ppm was recorded during a 62 minute monitoring period (Figure 10). The peak value on this occasion was 3.25 ppm and the 30-minute average varied from 0.51 to 1.2 ppm. The Ontario standard was violated for the entire monitoring session. During a later survey on August 22, symptoms of acute sulphur dioxide injury were noted on vegetation foliage on the same side of the mill.

CARBON MONOXIDE

During the sulphur dioxide surveys conducted by the mobile unit, elevated levels of carbon dioxide were measured at some locations (sites 3, 4, 6 and 12 in Table 8). The Ontario standard (approx. 5 ppm) was exceeded, but monitoring periods were too short to determine whether the 1-hour criterion was violated. The maximum peak and mean values (80.0 and 14.6 ppm respectively) were recorded at site 12. All sites were subject to fairly heavy vehicular traffic which probably contributed to the observed carbon monoxide levels.

MERCURY

The mobile unit also carried out a brief monitoring survey at a fenced site where mercury-laden wastes were buried near the former Dow Chemical chlor-alkali plant. The disposal site was monitored for 33 minutes on June 18, with the sample probe 7 metres from the fence line. The average mercury concentration was 0.46 $\mu g/m^3$, with a peak of 1.05 µg (Figure 11). The average was higher than background levels associated with uncontaminated air, but well below the Ontario half-hour standard of 5 $\mu g/m^3$.

HYDROGEN SULPHIDE

A continuous hydrogen sulphide analyzer was installed in June at 435 James Street South. This site is about 3,000 metres north-northeast of the Great Lakes Paper kraft mill, the most likely local industrial source of H_2S emissions. The maximum concentration recorded from June to December was 5 parts per billion (ppb) for a 1-hour period and the maximum 24-hour value was 1 ppb. The 1-hour criterion is 20 ppb. Higher levels might have been recorded had the kraft mill not been shut down from September onward.

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- Thunder Bay Regional Laboratory, Northwestern Region, for carrying out dustfall analyses and filter weight determinations for suspended particulate.

- Air Quality Laboratory, Laboratory Branch, for preparing and supplying lead dioxide candles and plates and determining sulphation rates, and for heavy metal analysis of suspended particulate.

- Air Quality and Meteorology Section, Air Resources Branch, for reading charts from continuous analyzers and preparing summaries of regional air quality data.

- Instrumentation Development and Monitoring Unit, Technology Development and Appraisal Section, Air Resources Branch, for carrying out special surveys in the vicinity of Thunder Bay industry.

- Environmental Protection Service, Environment Canada, for supplying an SO_2 analyzer, a high-volume sampler, and a COH unit for use in Thunder Bay.

TABLE 1. Levels of dustfall (tons/sq.mi./30 days) in Thunder Bay, 1975.

Station	Location	Month												Mean
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
63003	185 Gore St.	6	10	16	23	20	-	15	13	14	11	7	5	13
63004	24 Mountain Rd.	12	12	10	6	18	10	11	8	9	10	8	2	10
63005	McKellar Hospital	12	11	30	21	14	10	14	4	13	15	12	7	14
63012	Dawson Court	6	9	15	12	19	16	10	10	6	12	7	3	10
63017	Kembur Engineering	6	18	21	21	19	18	6	16	18	21	14	4	15
63018	St. Ignatius School	4	6	11	11	13	7	7	8	7	9	5	1	7
63019	Main St. Sewage Plant	6	9	9	10	10	9	13	9	13	16	12	3	10
63020	Hodder Ave. Fire Hall	7	13	10	11	16	16	19	35	34	18	8	4	16
63021	Mission Island	17	29*	21	10	14	14	20	15	18	20	28	23	19
63022	14 Algoma St.	9	8	21	22	21	14	13	11	16	14	10	3	14
63024	Hammond Ave./Inter-City	12	9	6	15	16	22	23	82	23	30	20	8	22
63025	Manitou St.	5	6	14	15	18	14	18	15	19	17	12	3	13
63026	N. Cumberland (Hydro)	8	9	9	23	19	22	20	17	21	16	18	7	17
63040	435 James St. South					10	11	15	8	9	-	7	2	9

*Levels exceeding the Ontario criterion of 20 (monthly) or 13 (yearly) are underlined.

TABLE 2. Levels of dustfall (tons/sq.mi./30 days) in Thunder Bay, 1970-75.

Station	Location	Year						Mean
		1970	1971	1972	1973	1974	1975	
63001	St. Ann School	14*	7	7				9
63002	Vickers Heights	18	13	10				14
63003	185 Gore St.	26	13	19	22	21	13	19
63004	24 Mountain Rd.	13	7	9	11	11	10	10
63005	McKellar Hospital	16	13	13	15	15	14	14
63006	Grey Park School	12	9	8				10
63007	St. Jude School	13	12					13
63008	St. John House	20	16	15				17
63009	Gron Morgan School	14	9	14				12
63010	St. James School	11	16					12
63011	St. Bernard School	11	8	8				9
63012	Dawson Court	14	8	12	14	13	10	12
63013	197 Otto St.	14	14	14				14
63014	205 Strathcona Ave.	17	11	11				13
63017	Kembur Engineering			7	14	17	15	15
63018	St. Ignatius School			6	10	10	7	9
63019	Main St. Sewage Plant			6	10	20	10	15
63020	Hodder Ave. Fire Hall			11	14	15	16	15
63021	Mission Island				15	15	19	17
63022	14 Algoma St.		13	12	15	16	14	17
63024	Hammond Ave.				37	29	22	27
63025	Manitou St.				19	13	13	15
63026	N. Cumberland (Hydro)				25	19	17	21
63040	435 James St. S.						9	9
	All stations	15	11	10	16	16	14	
	% of stations exceeding criterion	64	20	24	77	70	50	

* Values exceeding the annual criterion of 13 are underlined.

TABLE 3. Levels of suspended particulate ($\mu g/m^3$) in Thunder Bay, 1975.

Date	Location						
	63001 St.Ann School	63005 McKellar Hospital	63012 Dawson Court	63017 Kembur Eng.	63018 St.Ignatius School	63022 14 Algoma St.	63040 435 James St. S.
Jan. 6	40	94	35	140	-	-	
12	19	24	22	41	23	26	
18	20	30	30	36	25	33	
24	40	33	58	89	-	52	
30	17	24	36	37	24	26	
Feb. 5	52	35	58	150	-	43	
11	21	34	32	35	17	49	
17	31	62	54	132	32	65	
23	22	22	22	30	16	22	
Mar. 1	38	34	27	121	17	43	
7	25	46	35	121	21	34	
13	55	52	43	103	24	51	
19	109	78	41	98	41	62	
25	38	-	41	66	-	29	
31	62	40	31	-	24	37	
April 6	69	57	39	62	34	47	
12	121*	100	84	186	114	117	new
18	-	38	-	72	22	59	station
24	terminated	111	57	216	69	114	92
30		59	68	83	60	119	62

* Values exceeding Ontario criterion of 120 $\mu g/m^3$ for 24 hours are underlined.

TABLE 3 (Continued)

Date	Location						
	63001 St.Ann School	63005 McKellar Hospital	63012 Dawson Court	63017 Kembur Eng.	63018 St.Ignatius School	63022 14 Algoma St.	63040 435 James St. S.
May 6		77	133	270	-	98	83
12		150	151	206	98	131	95
18		65	-	106	92	50	47
24		93	172	143	143	126	195
30		72	30	220	57	-	78
June 5		42	55	144	31	71	35
11		75	128	136	78	123	92
17		200	201	248	124	-	-
23		63	82	141	59	70	60
29		-	57	74	-	78	48
July 5		74	94	130	80	80	85
11		60	34	68	21	35	33
17		113	166	269	103	190	202
23		42	104	71	41	76	41
29		80	173	251	-	199	128
Aug. 4		21	24	43	21	25	24
10		36	51	70	34	-	28
16		80	40	109	33	56	33
22		-	46	86	35	39	31
28		37	45	68	42	73	38

TABLE 3 (Continued)

Date	Location						
	63001 St.Ann School	63005 McKellar Hospital	63012 Dawson Court	63017 Kembur Eng.	63018 St.Ignatius School	63022 14 Algoma St.	63040 435 James St. S.
Sept. 3		46	20	45	22	28	-
9		87	72	116	47	84	30
15		72	62	-	-	68	61
21		-	13	45	15	25	13
27		115	-	203	74	82	63
Oct. 3		48	-	85	37	53	-
9		71	71	75	51	90	53
15		20	9	45	9	19	11
21		52	40	111	56	44	54
27		84	106	210	86	158	60
Nov. 2		61	25	104	47	53	39
8		71	33	136	39	35	37
14		57	-	157	47	73	41
20		51	11	16	20	17	11
26		-	38	-	19	-	-
Dec. 2		17	14	16	14	21	-
8		39	44	59	37	42	31
14		15	-	16	16	-	11
20		13	-	15	12	-	10
26		17	-	28	17	-	14

TABLE 4. Suspended particulate (annual geometric mean, $\mu g/m^3$) in Thunder Bay, 1970-75.

	Station									
	63001	63005	63007	63008	63011	63012	63017	63018	63022	63040
1963									100	
1964									93	
1965									66	
1966									67	
1967									77	
1968									71	
1969									115	
1970	82*	62	100	121	73	75			81	
1971	42	64	85	95	68	52			69	
1972	79	55		144		55			60	
1973	68	69				59	107	40	74	
1974	61	61				51	102	40	60	
1975	40	51				47	85	36	55	43

*Values exceeding the Ontario criterion of 60 $\mu g/m^3$ are underlined.

TABLE 5. Concentrations ($\mu g/m^3$) of lead and other heavy metals found in filters exposed at station 63022 (14 Algoma Street), Thunder Bay.

Element	Year	Number of samples	Concentration		
			Maximum	Mean	Minimum
Cadmium*	1973	17	0.010	0.003	ND**
	1975	7	ND	ND	ND
Copper	1973	17	0.09	0.05	0.01
Lead	1973	36	1.50	0.80	0.20
	1974	31	1.20	0.60	0.20
	1975	52	1.40	0.40	0.10
Manganese	1975	7	0.13	0.07	0.04
Nickel	1973	17	0.26	0.03	ND
Vanadium	1973	17	0.11	0.02	ND
	1975	7	0.03	0.01	ND

*Ontario ambient air criteria (or standards) are: cadmium - 2 $\mu g/m^3$, copper - 100 (standard), lead - 5, manganese - 100 (standard), nickel - 2, vanadium - 2.

**Not detectable.

TABLE 6. Sulphation rate (mg SO_3/100 cm^2/day), Thunder Bay, 1975.

Station	Location	Month												Mean
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
63003	185 Gore St.	.20	.14	.18	.16	.25	-	.13	.04	.04	.06	.07	.11	.13
63004	24 Mountain Rd.	.43	.34	.29	.37	.10	.10	.18	.10	.05	.05	.07	.08	.08
63005	McKellar Hospital	.17	.10	.11	.10	.15	.07	.12	.03	.05	.06	.07	.05	.09
63012	Dawson Court	.17	.07	.09	.11	.07	.09	.10	.04	.05	.07	.07	.07	.08
63017	Kembur Engineering	.14	.08	.11	.14	.05	.10	.16	.07	.08	.07	.07	.07	.10
63018	St. Ignatius School	.12	.07	.06	.06	.10	-	-	.03	.04	.07	.05	.07	.07
63019	Main St. Sewage Plant	.16	.10	.10	.14	.04	.27	.20	.07	.16	.10	.09	.07	.13
63020	Hodder Ave. Fire Hall	.15	.10	.10	.08	.16	.22	.13	.03	.06	.07	.05	.08	.10
63022	14 Algoma St.	.18	.16	.12	.13	.09	.06	.10	.04	.06	.09	.10	.13	.11
63040	435 James St. South						.04	.08	.03	.03	.06	.08	.05	.05

TABLE 7. Sulphation rates (mg SO_3/100 cm^2/day) in Thunder Bay, 1970-75.

Station	Location	Year						Mean
		1970	1971	1972	1973	1974	1975	
63001	St. Ann School	.11	.07	.08				.09
63002	Vickers Heights	.07	.06	.05				.06
63003	185 Gore St.	.16*	.13	.08	.07	.10	.13	.11
63004	24 Mountain Rd.	.21	.21*	.16	.16	.16	.18*	.18
63005	McKellar Hospital	.09	.09	.09	.09	.08	.09	.09
63006	Grey Park School	.11	.09	.11				.10
63007	St. Jude School	.10	.10	.01				.08
63008	St. John House	.08	.06	.06				.07
63009	Gron Morgan School	.12	.09	.09				.10
63010	St. James School	.09						.09
63011	St. Bernard School	.10	.08	.08				.09
63012	Dawson Court	.14	.10	.09	.11	.09	.08	.10
63013	197 Otto St.	.09	.06	.06				.07
63014	205 Strathcona Ave.	.12*	.11	.10				.08
63016	Broadway Ave.			.03				.03
63017	Kembur Engineering			.08	.10	.09	.10	.09
63018	St. Ignatius School			.07	.07	.06	.07	.06
63019	Main St. Sewage Plant			.09	.24***	.11	.13	.16
63020	Hodder Ave. Fire Hall			.12	.10	.10	.10	.10
63022	14 Algoma St.		.12	.13	.14	.12	.11	.12
63040	435 James St. S.						.05	.05
	Mean	.11	.09	.08	.12	.10	.11	

*Former criterion of 0.40 mg/100 cm^2/day exceeded during one month.

***Former criterion of 0.40 mg/100 cm^2/day exceeded during three months.

TABLE 8. Levels of sulphur dioxide recorded in the vicinity of sulphite pulp mills, Thunder Bay, June, 1975.

Source	Site	Distance and direction from source*	Date	Period monitored	SO_2 concentration (ppm) Max.	Mean	Min.
Great Lakes Paper	1	1250 m NNW	18.6.75	16:55-17:24	0.09	0.02	nil
	2	600 m ESE	23.6.75	14:25-14:57	2.01	0.27	0.04
	3	750 m SW	24.6.75	16:50-17:20	0.92	0.06	nil
	4	1000 m SW	"	18:00-18:30	<0.01	<0.01	nil
	5	1500 m SSW	"	10:45-11:19	0.13	0.03	<0.01
Abitibi (Thunder Bay)	6	350 m W	25.6.75	14:25-14:53	0.13	0.02	<0.01
	7	"	"	15:00-15:32	0.08	0.03	<0.01
	8	"	"	18:00-18:48	0.05	0.02	<0.01
	9	400 m W	26.6.75	13:37-14:05	0.15	0.03	<0.01
Abitibi (Provincial)	10	750 m WSW	20.6.75	16:45-17:17	0.20	0.07	0.01
	11	670 m W	25.6.75	11:50-12:14	0.80	0.41	0.22
	12	750 m W	"	16:00-16:34	0.48	0.07	0.01
	13	800 m NW	26.6.75	11:58-12:29	0.67	0.10	<0.01
Abitibi (Mission)	14	1300 m WNW	25.6.75	14:42-15:44	3.25	0.81	0.07

*Measured from kraft mill recovery stack at Great Lakes Paper and digester stack(s) at Abitibi mills.

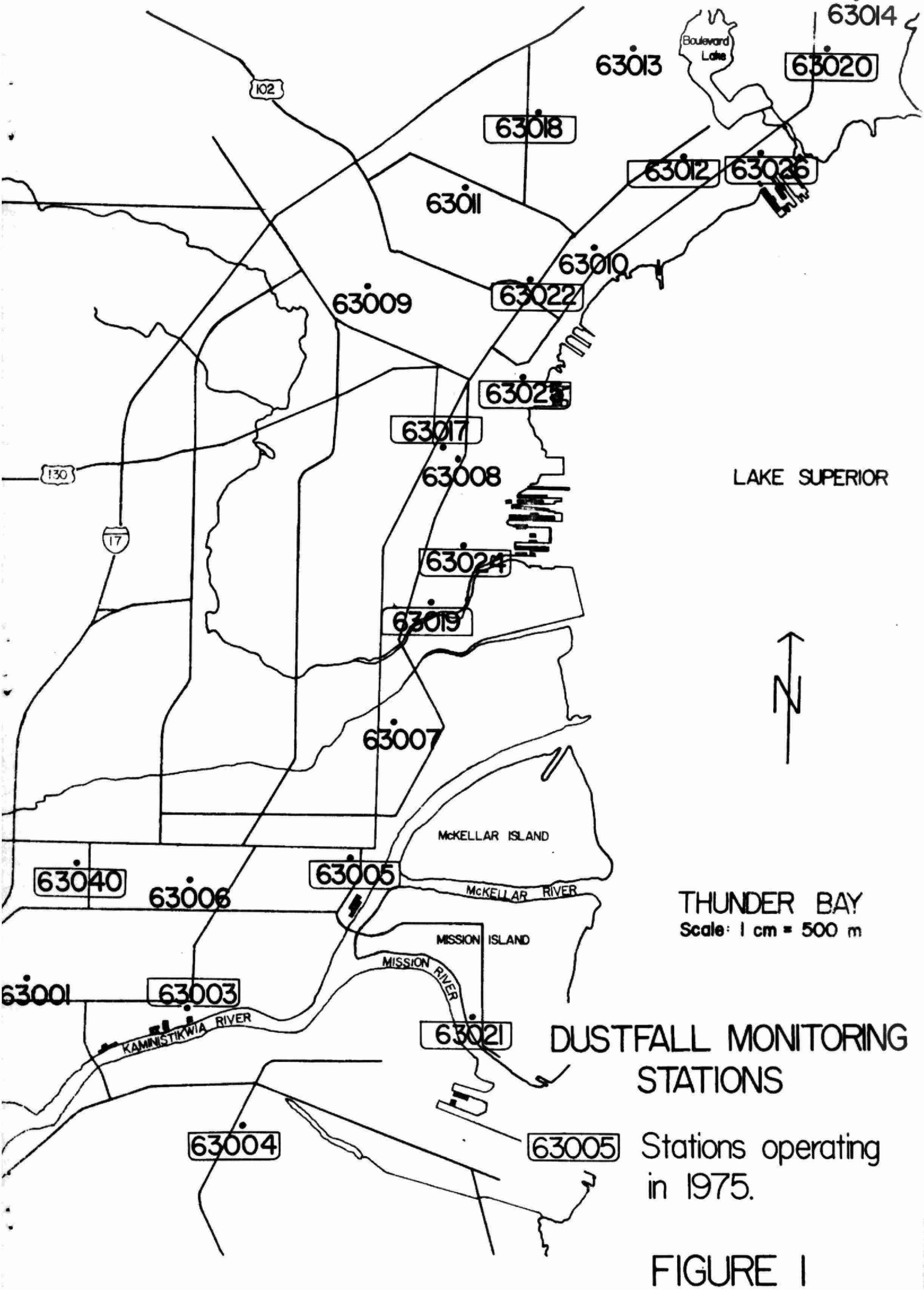
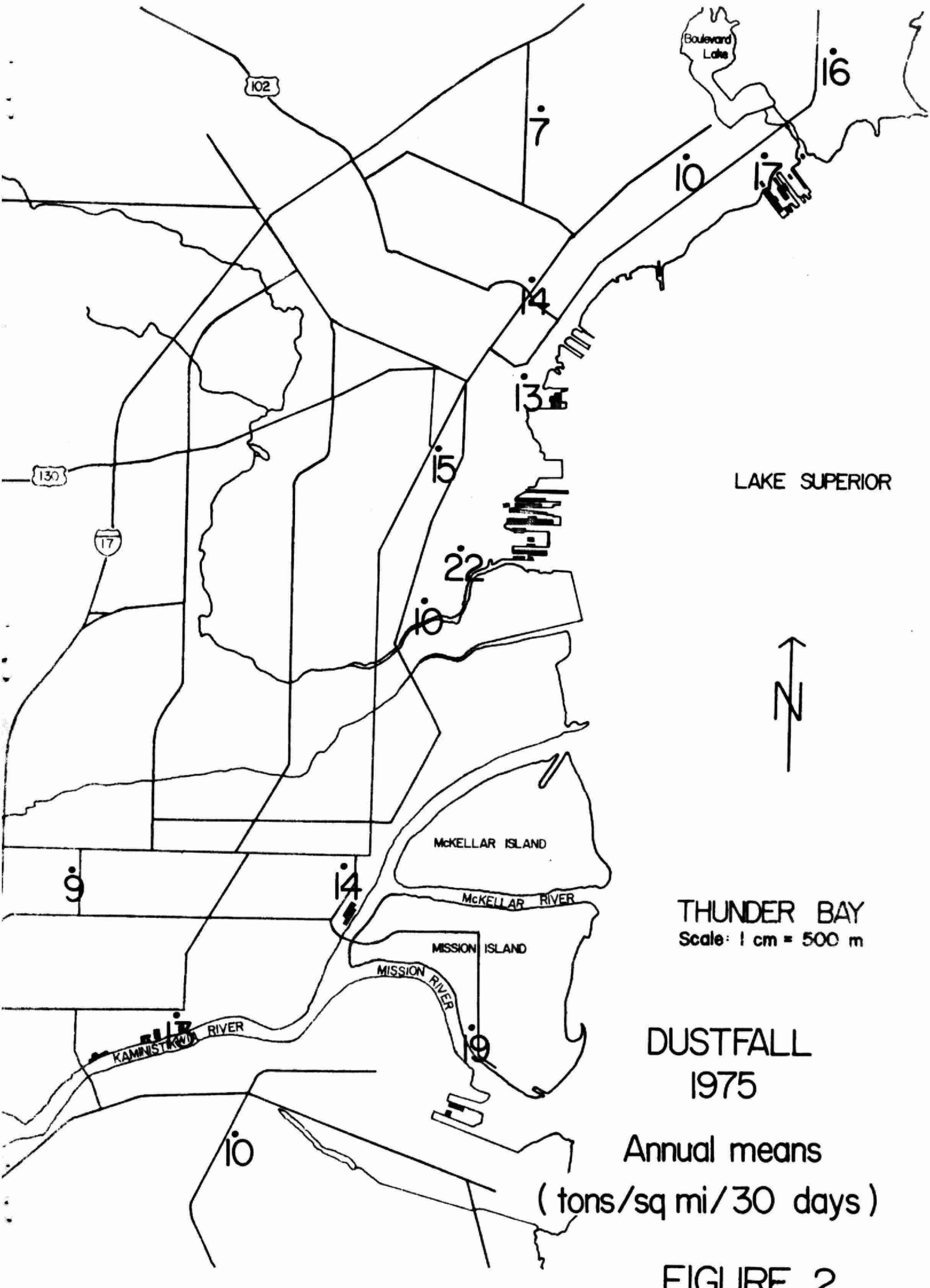

63014
Boulevard Lake
63013
63020
102
63018
63012
63026
63011
63010
63009
63022
63023
63017
63008
130
LAKE SUPERIOR
17
63024
63019
63007
McKELLAR ISLAND
63040
63005
63006
McKELLAR RIVER
MISSION ISLAND
MISSION RIVER
63001
63003
KAMINISTIKWIA RIVER
63021
63004
63005
THUNDER BAY
Scale: 1 cm = 500 m
DUSTFALL MONITORING STATIONS
Stations operating in 1975.

FIGURE 1



THUNDER BAY
Scale: 1 cm = 500 m

DUSTFALL 1975

Annual means (tons/sq mi/30 days)

FIGURE 2

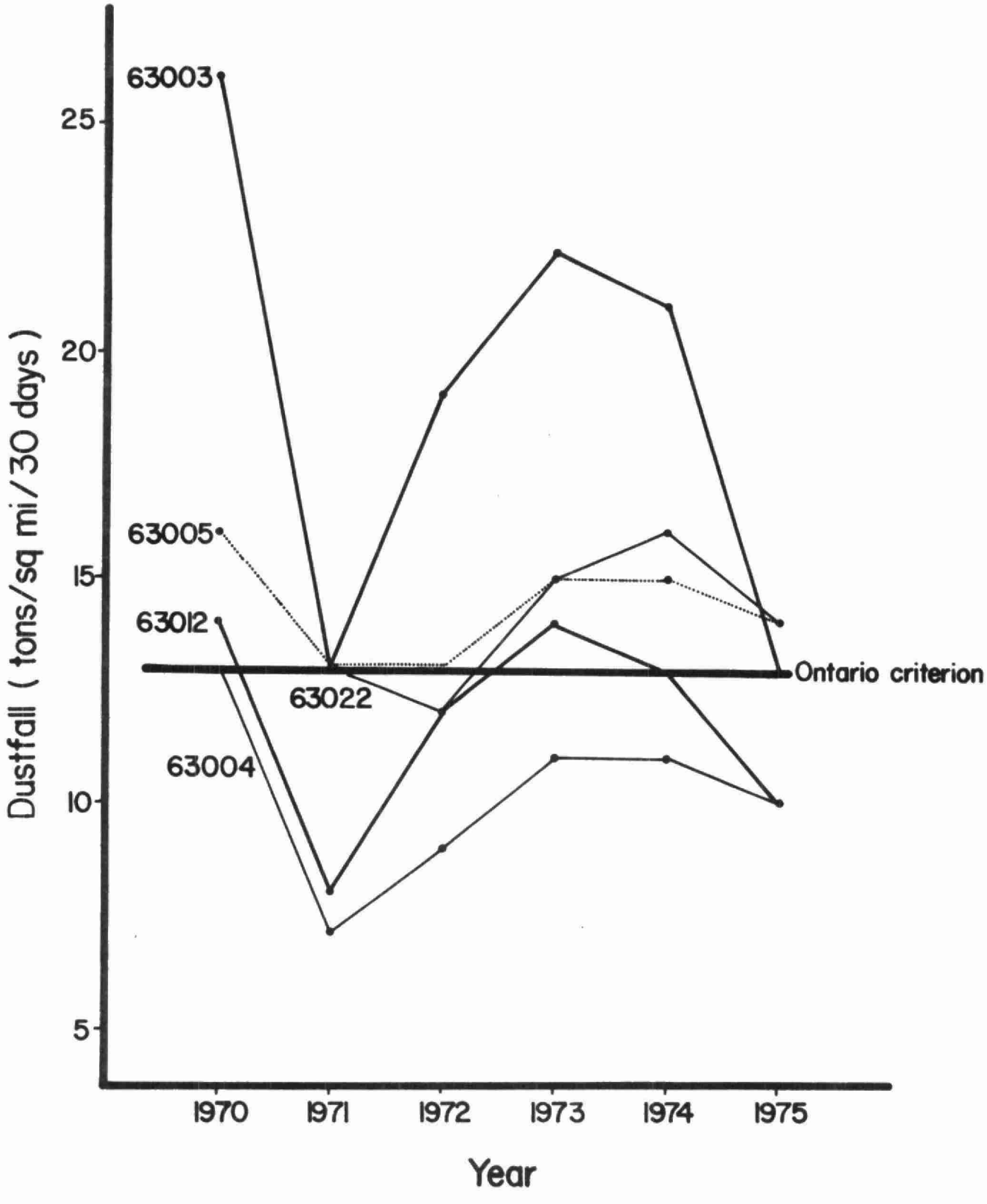


FIGURE 3 Dustfall in Thunder Bay, 1970 - 1975.

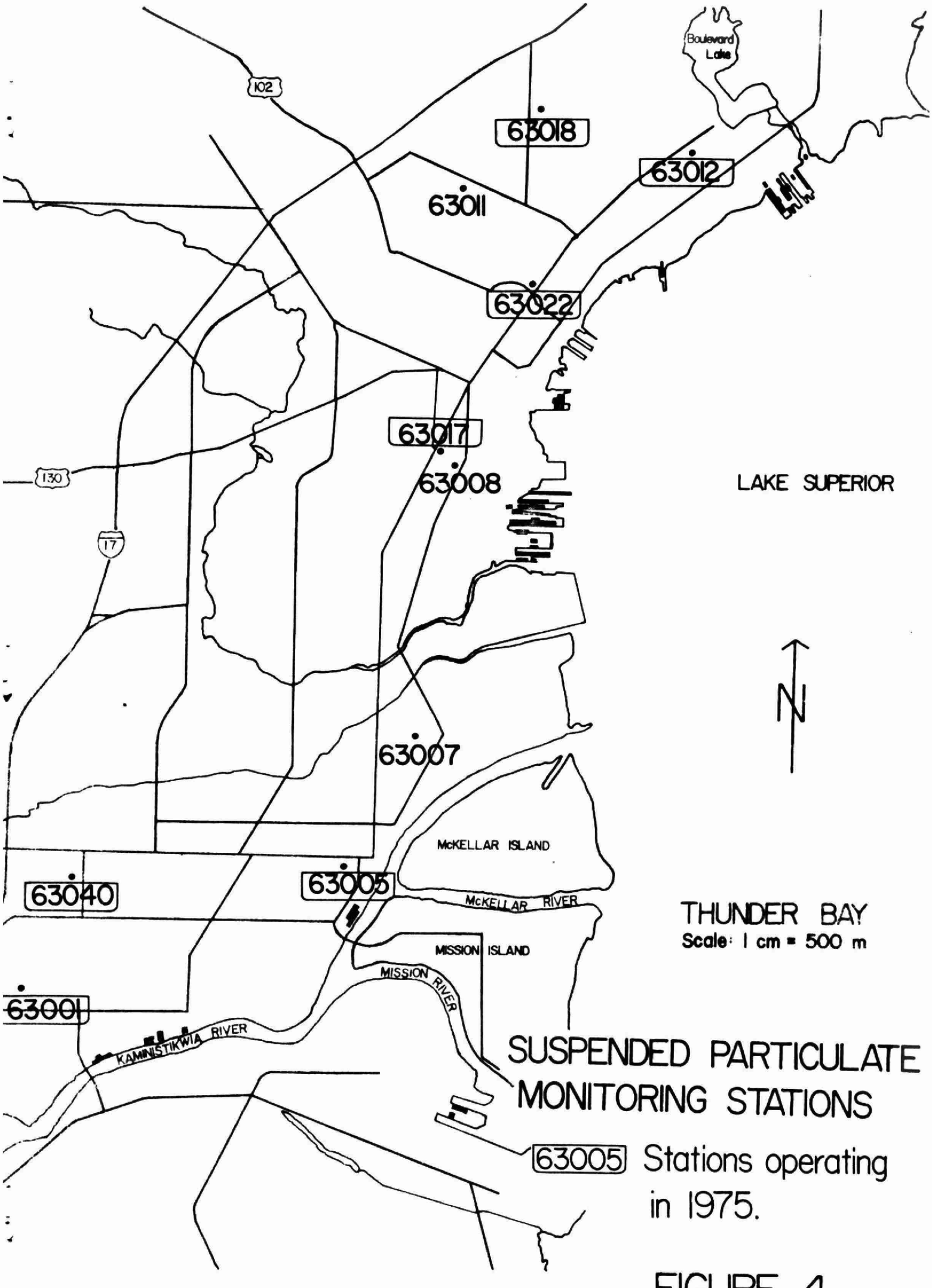

Boulevard Lake
102
63018
63012
63011
63022
63017
63008
130
17
LAKE SUPERIOR
N
63007
McKELLAR ISLAND
63040
63005
McKELLAR RIVER
THUNDER BAY
Scale: 1 cm = 500 m
MISSION ISLAND
MISSION RIVER
63001
KAMINISTIKWIA RIVER
SUSPENDED PARTICULATE MONITORING STATIONS
63005 Stations operating in 1975.

FIGURE 4

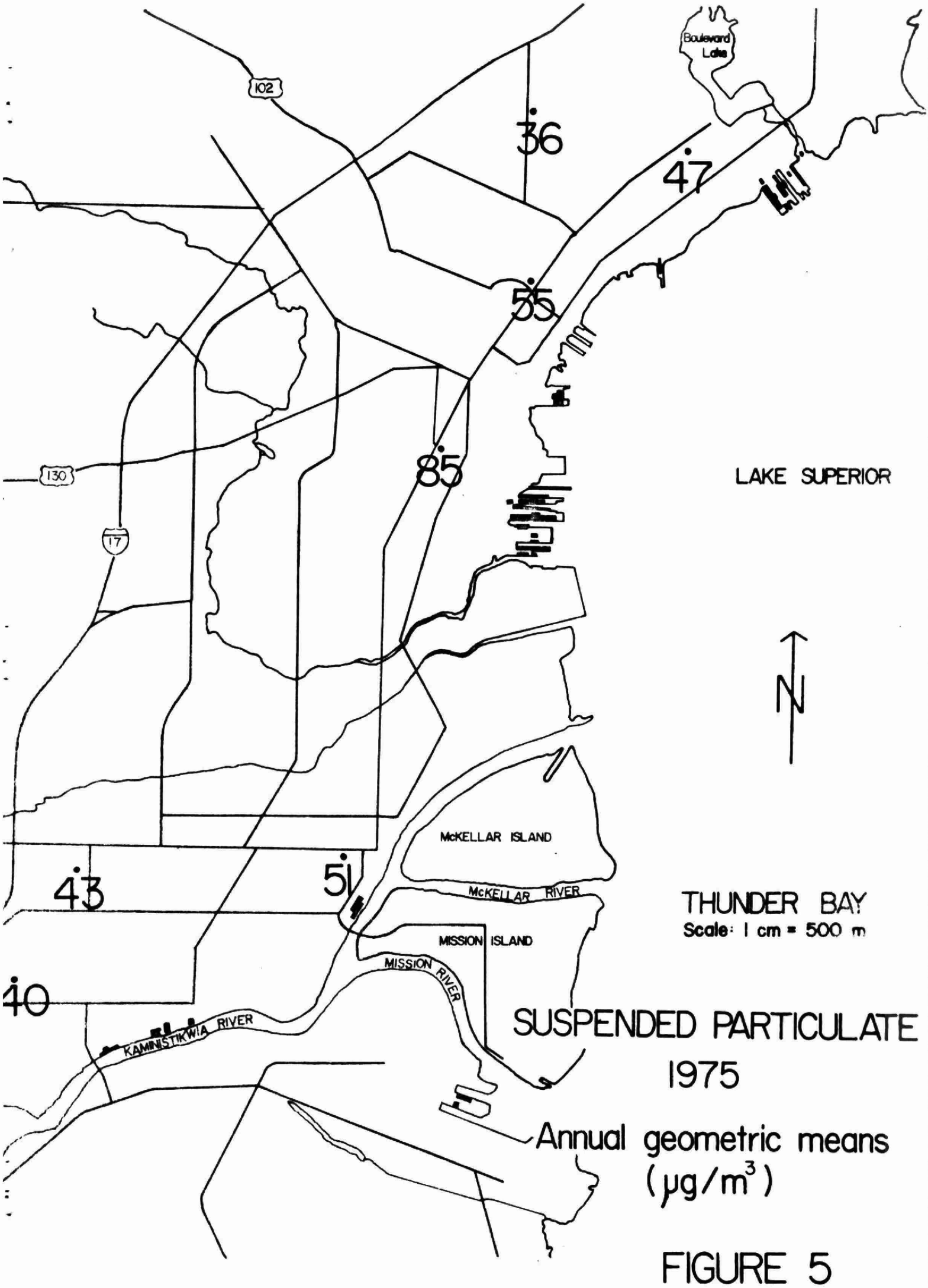

Boulevard Lake
102
36
47
55
85
130
17
LAKE SUPERIOR
N
McKELLAR ISLAND
43
51
McKELLAR RIVER
THUNDER BAY
Scale: 1 cm = 500 m
MISSION ISLAND
MISSION RIVER
40
KAMINISTIKWIA RIVER
SUSPENDED PARTICULATE
1975
Annual geometric means
(μg/m³)

FIGURE 5

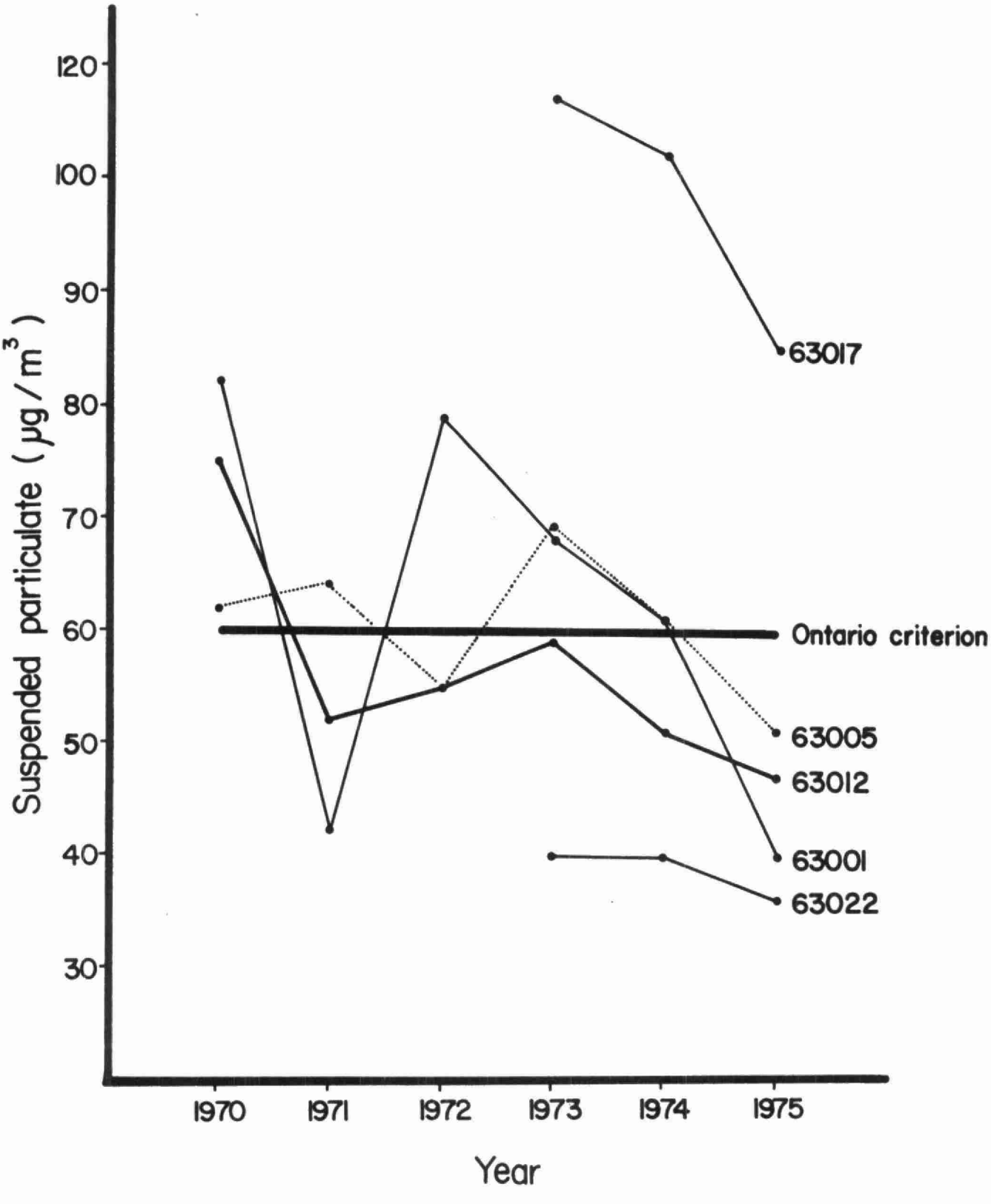
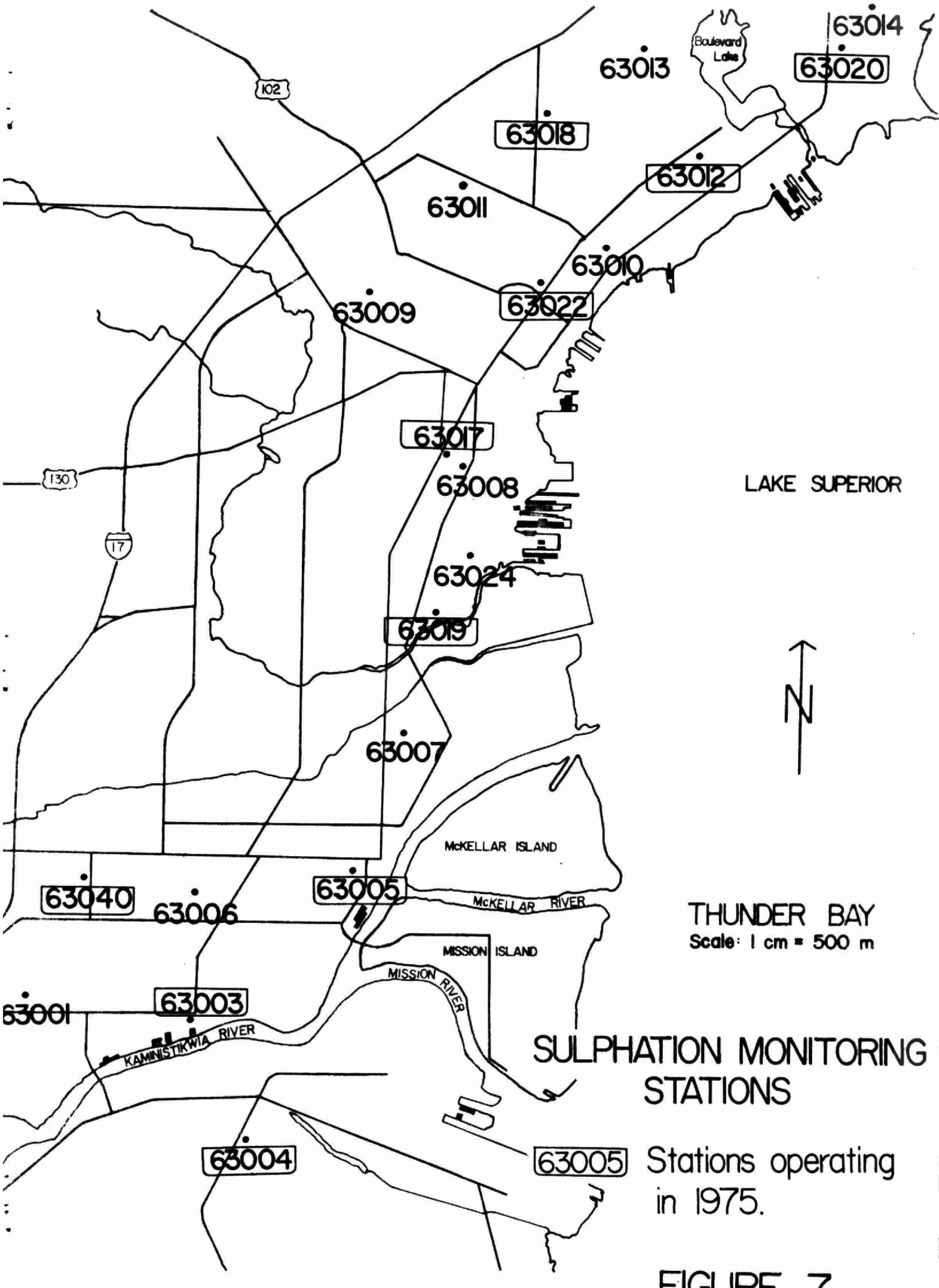


FIGURE 6 Suspended particulate in Thunder Bay, 1970-1975.



THUNDER BAY
Scale: 1 cm = 500 m

SULPHATION MONITORING STATIONS

FIGURE 7

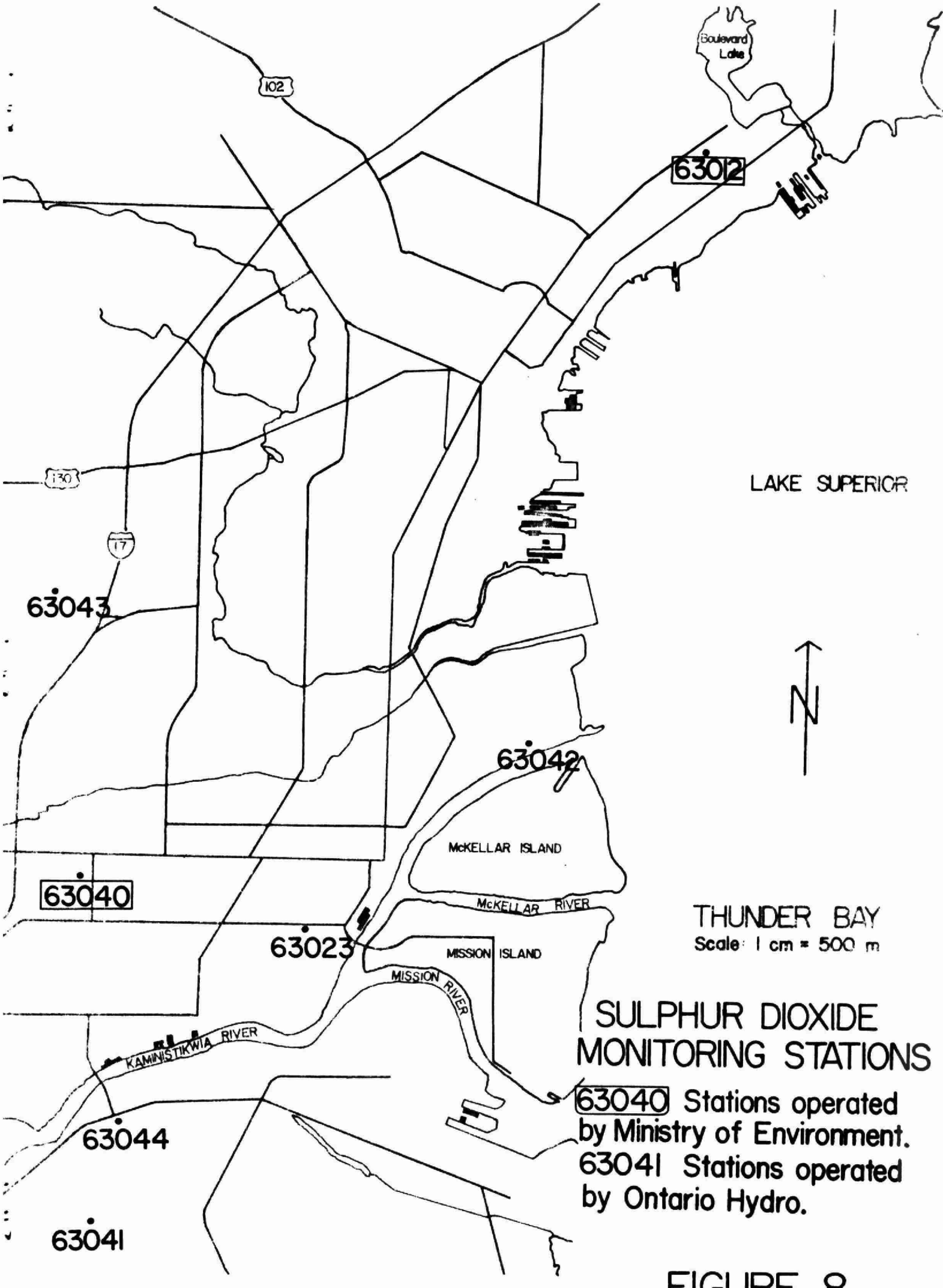

Boulevard Lake
102
63012
130
17
LAKE SUPERIOR
63043
63042
McKELLAR ISLAND
63040
McKELLAR RIVER
63023
MISSION ISLAND
MISSION RIVER
KAMINISTIKWIA RIVER
63044
63041
N
THUNDER BAY
Scale: 1 cm = 500 m
SULPHUR DIOXIDE MONITORING STATIONS
63040 Stations operated by Ministry of Environment.
63041 Stations operated by Ontario Hydro.

FIGURE 8

CONCENTRATION VS TIME

SURVEY: THUNDER BAY SITE # 2
DATE: JUN 23 1975
SCAN TIME: 30 SEC
STANDARD: 0.3 PPM
LOCATION: HWY #518 @ TRAILER PARK

POLLUTANT: SO2
START TIME: 14:25
AVERAGING TIME: 30 MIN
DISTANCE: .6KM/ 80DEG FROM GLP

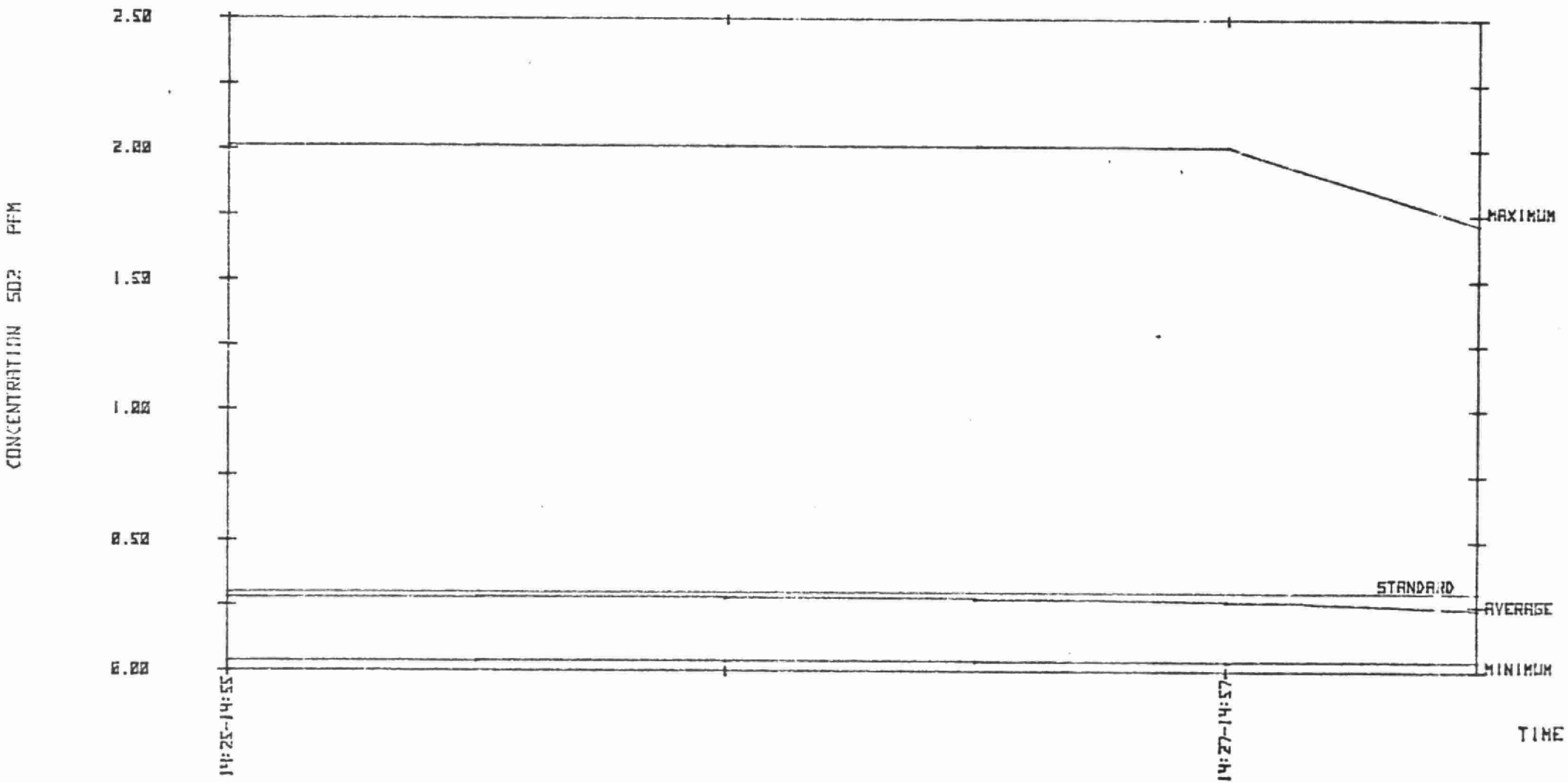


FIGURE 9

CONCENTRATION VS TIME

SURVEY: THUNDER BAY SITE # 14
DATE: JUN 26 1975
SCAN TIME: 60 / SEC
STANDARD: 0.3 PPM
LOCATION: RR TRACK WNW OF MILL

POLLUTANT: SO2
START TIME: 14:42
AVERAGING TIME: 30 MIN
DISTANCE: 1.3KM/ 310DES FROM A.M

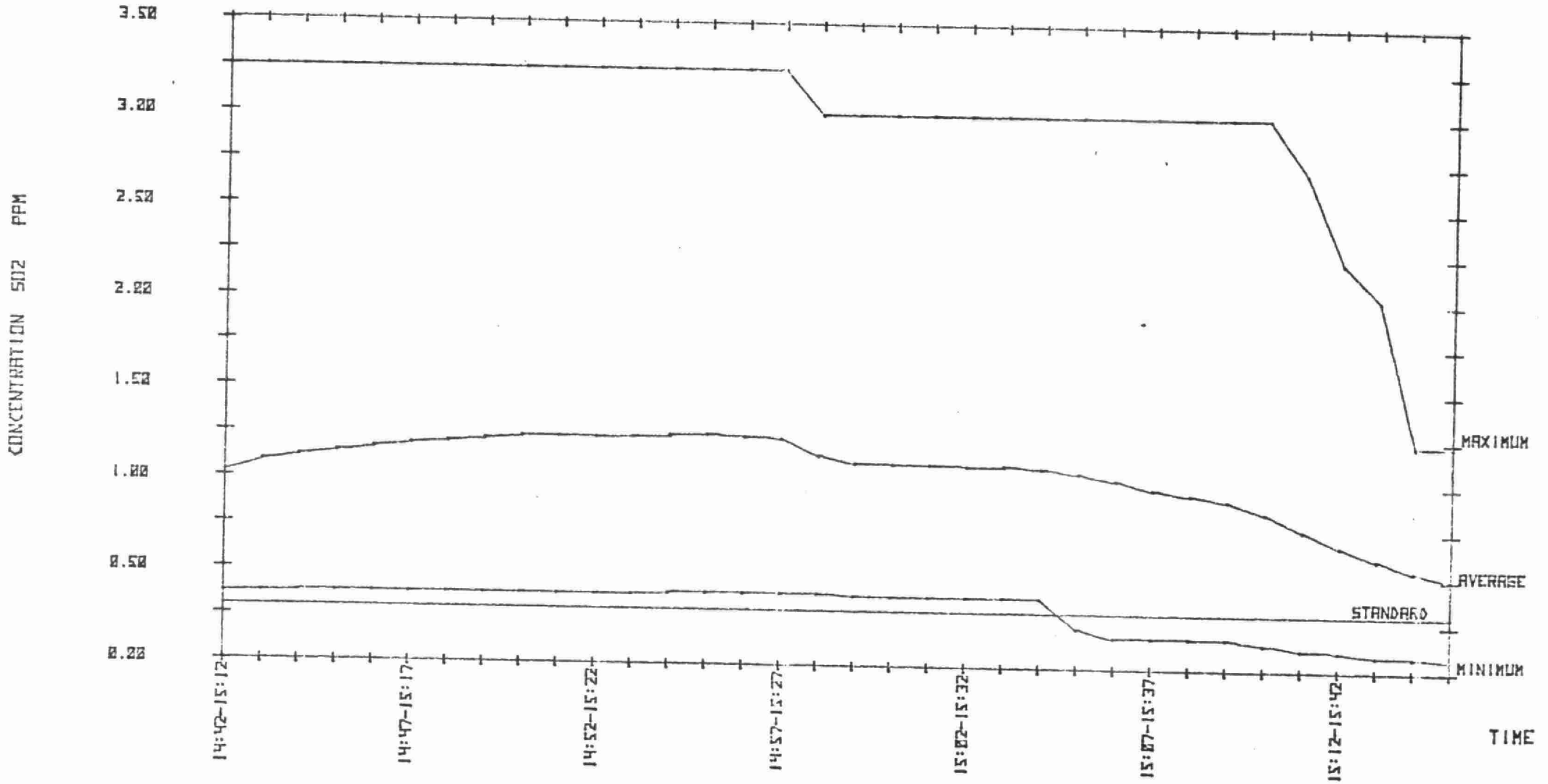


FIGURE 10

CONCENTRATION VS TIME

SURVEY: THUNDER BAY #1
DATE: JUN 18 1975
SCAN TIME: 60 SEC
STANDARD: 5 UG/M3
LOCATION: 7M FROM DUMP SITE

POLLUTANT: HG
START TIME: 14:25
AVERAGING TIME: 15 MIN
DISTANCE: .1KM/ 90DEG FROM DOW

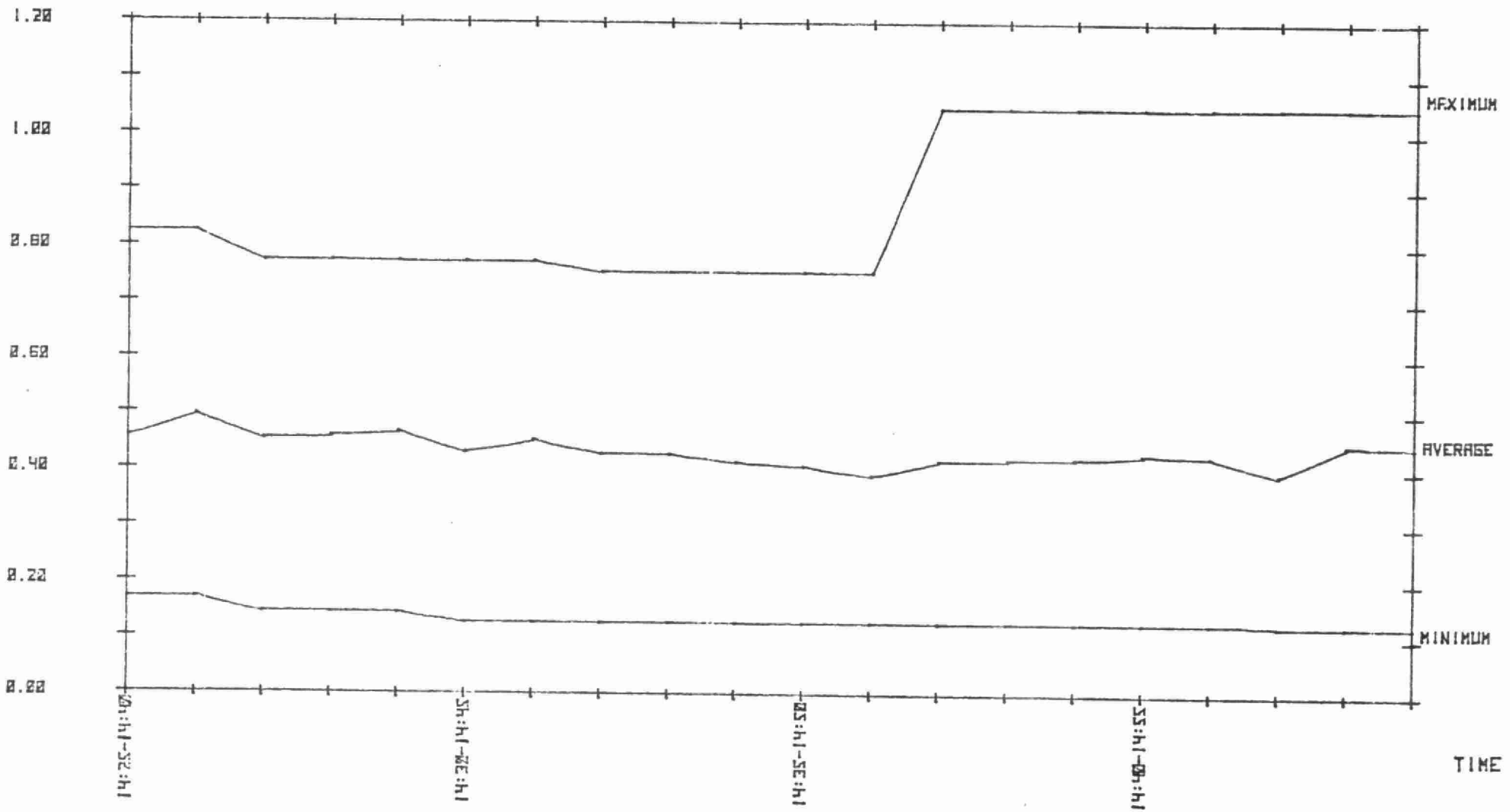


FIGURE 11

ONTARIO: O.W.R.C.